WATER QUALITY

OF

GERMAN MILLS CREEK

(DON RIVER TRIBUTARY)

IN RELATION TO

THE PUGSLEY STREET SEWAGE TREATMENT PLANT - RICHMOND HILL

REGIONAL MINICIPALITY OF YORK

Ministry of the Environment

Ontario

P. G. Cockburn, P. Eng.
Regional Director
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RECOMMENDATIONS

1. Chlorination practice at the plant should be reviewed and chlorine dosages should be reduced to ensure that the Ministry objective of maintaining a chlorine residual of 0.5 mg/l after a 15 minute contact time is generally not exceeded.

2. At the time when the Arnold Street Pumping Station sewage flows are diverted to the BAIF Plant, new development in areas tributary to the Pugsley Street Plant should be limited to a population equivalent of 1,900 people or 110,000 IGPD.

I N T R O D U C T I O N

A meeting was held on July 2, 1975, between the Ministry of the Environment and officials of the Town of Richmond Hill and the Regional Municipality of York, to consider sewage treatment capacities for the Richmond Hill area and specifically to review plans to divert the Arnold Street Pumping Station sewage flows from the Pugsley Street Plant to the BAIF Plant.

It was agreed that the staff of the Central Region would undertake an assessment to determine what, if any, additional flows may be received at the Pugsley Street Plant at the time when the Arnold Street Pumping Station sewage flows are diverted to the BAIF Plant.

In conjunction with staff from the Regional and Town Engineering Departments, staff of the Central Region assessed the following :

a) the limitations on the Pugsley Street Sewage Treatment Plant;

b) the flows being diverted from the Pugsley Street Sewage Treatment Plant and;

c) the capabilities of the receiving body of water to assimilate sewage plant effluent.

Base flow in German Mills Creek is minimal during the low-flow summer periods consisting mainly of treated effluent downstream of the treatment plant effluent out-fall. This report assesses the relationship between the water quality in German Mills Creek, and the quality and quantity of sewage treatment plant effluent. In addition, the report outlines flows associated with the Arnold Street Pumping Station.

Sources of information relating to the present assessment are included in Appendix A.

METHODOLOGY - 1975 FIELD SURVEY

During the low-flow period of July 29 to September 3, 1975, water quality was monitored at a total of eight stream locations (Figure 1). The final treatment plant effluent (sampling station #3) was also sampled on each sampling run. Sampling runs were carried out on July 29, August 5, August 11, August 13-14, August 29, and September 2-3. The August 13-14 sampling period included one day-time run (4.00 - 6.00 PM) plus one night-time run (2.20 - 4.15 AM), and the September 2-3 sampling period included a total of six sampling runs (every 4 hours) during the 24-hour period. Through this monitoring program, typical low-flow, day-time conditions were evaluated, as well as the diurnal-nocturnal quality fluctuations.

Although water-quality was monitored at all nine sampling locations on each of the 12 sampling runs, parameters were not consistent from one sampling run to the next. The parameters measured for each run are included in Appendix B.

RESULTS

This report does not contain all of the analytical data obtained from the 1975 field survey. However, this analytical data is appended to copies of this report available in the Central Region files (Technical Support Section) of the Ministry of the Environment.

Flow - Visual observations revealed that the streamflow in the study area was similar for all 12 sampling runs. Figure 2 illustrates the streamflow measured at five of the creek stations on September 4. Figure 2 also illustrates the ratio of background streamflow to the average "dry-weather" flow of the sewage treatment plant.

Comparisons between the September 4 measured flows and the flows obtained from 1970 to 1974 at the staff gauge on German Mills Creek reveal that the 1975 field survey was carried out when flows were typical of the low-flow summer period (Figure 1).

Temperature - The minimum temperature measured was 12.3°C, while the maximum temperature was 26.5°C.

Dissolved Oxygen - The dissolved oxygen data, with the exception of the August 11 sampling run, is illustrated in Figure 3. (The August 11 data is excluded since an old titrating solution was used).

The data reveal that in general, the supply of dissolved oxygen in the study area is adequate for a healthy aquatic biota, including warm-water fish species. As expected, the effluent from the sewage treatment plant is considerably under saturation; however, even the effluent has sufficient oxygen to support coarse fish. Once the effluent has reached station 4, dissolved oxygen levels are similar to the upstream controls.

In general, the diurnal-nocturnal data reveal only small fluctuations during the 24-hour period, particularly between Station 1 to 7 inclusive. At stations 7, and 9, the diurnal-nocturnal fluctuations are several mg/l, indicating moderate aquatic-plant growth.

5-Day Biochemical Oxygen Demand and Total Organic Carbon - Figure 4 illustrates the BOD_5 and TOC data. In general, the BOD_5 is typical of an urban stream, with no major differences between sampling points. It is of interest to note that the

sampling location with the lowest BOD_5 was the sewage plant effluent. The effluent has a surprisingly low BOD_5. Not unlike the BOD_5 data, the TOC values are fairly consistent from one sampling location to the next.

Suspended Solids - The concentration of suspended solids, illustrated in Figure 4, are not grossly different from one sampling location to the next. It is of interest to note, however, that the effluent is generally lower in suspended solids than the downstream creek waters.

Conductivity - Conductivity values (Figure 5) for German Mills Creek are fairly high. It is evident that the effluent significantly increases the salt content of the Creek. Whether or not the salt content of the Creek would limit the usefulness of the Creek for irrigation would depend on the specific ionic nature of the water, as well as the types of plants irrigated.

Phosphorus - Figure 5 illustrates the phosphorus data. Since the effluent is very high in phosphorus with respect to the upstream creek waters, the effluent results in a high concentration of phosphorus between the Pugsley Street Plant and the mouth of German Mills Creek. However, the average total

phosphorus content decreases substantially from approximately 4 mg/l at station 4, to approximately 1.5 mg/l at station 7, illustrating the substantial incorporation of this nutrient into aquatic plants; because the phosphorus concentration is substantially reduced by the time German Mills Creek reaches the East Don, and because of the dilution provided by the East Don, there is a fairly small increase in phosphorus from station 8 to station 9 (see Figure 1).

Nitrogen - The data on total kjeldahl nitrogen, nitrate and free ammonia is illustrated in Figures 6. Not unlike the data on BOD_5 and TOC, the kjeldahl data provides further evidence of the high degree of efficiency of the Pugsley Plant in mineralizing the organics. While the kjeldahl values at stations 3, 4 and 5 are substantially above those of the upstream controls, the total kjeldahl concentration of the effluent is low for a conventional activated sludge plant. It is also of interest to note that a substantial part of the kjeldahl nitrogen in the plant effluent, and in the downstream creek waters, is free ammonia (figure 6).
Because of this, the kjeldahl values drop substantially from station 3 to 6 as the ammonia fraction is oxidized.

The nitrate concentrations downstream from the sewage treatment plant are unfavourably high, and appear to be highest at

station 5. The increase of nitrate from station 3 to station 4 to station 5 largely reflect the oxidation of ammonia and nitrite. Downstream from station 5, nitrate decreases as biological assimilation of this nutrient exceeds the rate of oxidation of ammonia and nitrite. It would appear that the nitrate carried by German Mills Creek results in only a small increase of nitrate in the East Don River (see Figure 6).

The concentration of ammonia in German Mills Creek at locations 3, 4 and 5 are high, and probably toxic to fish and most stream invertebrates. At the remaining locations in the study area, it would appear that ammonia levels are low enough to allow the survival of the hardier varieties of fish and other aquatic biota.

Chlorine - Figure 8 illustrates total available chlorine. Like the ammonia data, the chlorine data indicates toxic conditions for most aquatic animals at locations 3, 4 and 5. At the remaining locations, chlorine levels should not be toxic during dry weather periods. Residual chlorine levels up to 1.9 mg/l were measured in the final plant effluent after approximately a 30-minute contact period, which significantly exceeds the Ministry objective of 0.5 mg/l of chlorine residual after a 15 minute contact period.

Bacterial - Figure 7 illustrates the data on total coliform bacteria. In general, the study area is unsuitable for body contact recreation because of the high coliform levels; the exception to this is the length of creek between the sewage treatment plant and station 5, where the coliform levels are very low because of the "dilution" of the disinfected effluent, and because of the residual chlorine in the effluent which kills many of the coliform bacteria in the creek.

Threshold Odour Number - Two sets of samples were collected for threshold odour. All samples required considerable dilution to achieve the TON. Dilutions ranged from 1:16 to 1:130. There is not sufficient data to detail the impact of the Pugsley Plant effluent on the odour of German Mills Creek. However, the two sampling runs provided no evidence of a major change in the TON of the creek resulting from the effluent.

OBSERVATIONS - REGARDING ARNOLD STREET PUMP STATION

Working with Mr. Bert Hull of the Town of Richmond Hill, Central Region staff performed pumping tests on the Arnold Street pump station. Pump test results indicated that the smaller pump which is used for regular service has a capacity of 114 GPM. The large pump has a capacity of 520 GPM and is used during high flows.

Flow measurements were made at the pump station using a time totalizer. From August 30 to September 5, the recorded times of pump operation at 114 IGPM gave an average day flow of 85,000 gallons. These figures were measured during dry weather.

Allowance for Wet Weather

In order to estimate flows which would normally include wet weather periods, the ratio of the average daily flow for the year at the Pugsley Sewage Treatment Plant (1.8 MIGD) to the daily flows metered at this plant during the September test (1.4 MIGD) was calulated to be 1.3:1. Thus it is assumed

that average daily flows at the Arnold Street Pump Station are approximately 1.3 x 85,000 = 110,000 IGPD.

House Count

A house count was conducted in the area served by the Arnold Street Pump Station and using the Town of Richmond Hill's population density figure for a single family dwelling of 3.3 persons per household, and 2.2 persons per apartment unit, it was calculated that the pump station serves approximately 1,900 people.

OBSERVATIONS - REGARDING PUGSLEY SEWAGE TREATMENT PLANT

Flows

The Parshall flume flow measurement at the Pugsley Plant was checked and found to be accurate. The design capacity of this plant is 1.6 MIGD. Since January 1974 it has been operating above capacity at 1.8 MIGD, with effluent concentrations from 1974 and 1975 to date as follows:

BOD = 8.5 mg/l; SS = 17.3 mg/l; Total Phosphorus = 3.3 mg/l.

Chlorination

Plant records indicate that dosages in the range of 6.0 mg/l chlorine are being maintained. This is some 50 per cent higher than dosages normally practiced in conventional secondary treatment plants. In view of the toxic effects of chlorine in the stream, chlorination procedures should be reviewed at the plant and dosages should be reduced to bring them more in line with the Ministry objective.

DISCUSSION

A brief review of the two 1966 reports of the Ontario Water Resources Commission provided minimal information in addition to that collected in the present 1975 study. In relating the two previous studies with the present study, the main pertinent points are as follows:

a) It would appear that the effluent quality from the Pugsley Street Plant has substantially improved in last nine years, particularly in terms of organic content, nitrogen, phosphorus and bacteria.

b) It would appear that in general the quality of German Mills Creek has improved in the last nine years; for example the minimum level of dissolved oxygen recorded in the creek in the 1966 reports was 0.8 mg/l, while the minimum creek level recorded in the present study was 3.0 mg/l.

c) Unlike the 1966 reports, the present survey did not include assessments of the aquatic animal population. However, it is expected that impairment to the inverte-

brate and fish communities is presently somewhat worse than nine years ago; although the animal habitat is probably better in terms of the general physical-chemical environment, the high residual chlorine downstream of the effluent probably results in toxic conditions extending at least two miles downstream from the Pugsley Street Plant. It is expected that in the lower reaches of German Mills Creek, there are coarse fish species (eg. some minnows) as well as a variety of the tolerant species of benthic invertebrates. The affect of German Mills Creek on the biology of the East Don River is expected to be very minimal, as was the case in the O.W.R.C. work nine years ago.

A review of the 1974 water-quality monitoring data collected by the Ministry on German Mills Creek provides no significant additional information to the present field study.

Consideration and interpretation of the available information can be summarized as follows:

1. In general, during the low-flow summer period, the Pugsley Street Plant effluent results in substantial ecological impairment to German Mills Creek between the point of discharge and sampling station 5. This

impairment is primarily a result of the high concentrations of ammonia and residual chlorine.

2. There is no doubt that some ecological impairment occurs in the lower reaches of German Mills Creek. However, it is expected that the biological communities in this area are reasonably well balanced since the levels of ammonia and chlorine are reduced to semi-toxic or non-toxic levels.

3. The ecological impact of the Pugsley Street Plant effluent on the East Don River are believed to be very minimal or negligible.

4. In general, the dissolved oxygen in German Mills Creek is sufficient to support a fairly well-balanced population of warm-water biota, including fish. These satisfactory levels of oxygen are a result of several things, including the low organic content of the treatment plant effluent, the high re-aeration capabilities of the creek due to its gradient, and the apparently limited production of aquatic plants.

5. In some respects (eg. BOD_5, TOC, suspended solids, bacteria) the treatment plant effluent improves the quality of German

Mills Creek. In other respects (e.g. N, P, chlorine, salt content) the effluent results in substantial adverse changes in the Creek. However, outside of the evidence of general ecological impairment, the authors are not aware of German Mills Creek being unsuitable for existing human uses. It should be pointed out, however, that the present study was not thorough, and that a detailed "use survey" was not carried out.

6. The 1975 creek study was carried out under low flow summer conditions. While it is difficult to predict the ecological impact of the Pugsley Street Plant on the Creek during higher flow periods, it is expected that the water quality of German Mills Creek would worsen during periods of precipitation.

Considering all of the above information, it is apparent that ecological impairment in German Mills Creek could be lessened by reducing the output of ammonia and residual chlorine from the sewage treatment plant. Also, the potential of German Mills Creek for a variety of human uses could be increased by decreasing the plant discharges of phosphorus, inorganic nitrogen, dissolved solids and suspened solids. The organic

loading to the creek does not appear to be a problem during dry periods.

Although the impact of the Pugsley Street Plant on the main East Don River is neglible in dry periods, it is possible that there is a significant, short-term impact (e.g. BOD, phosphorus) during periods of precipitation.

SUMMARY AND CONCLUSION

The quality of German Mills Creek is substantially affected by the effluent from the Pugsley Street Sewage Treatment Plant. For a distance of approximately two miles downstream of the plant outfall, levels of residual chlorine and ammonia would indicate toxic conditions for most stream biota.

Chlorination practice at the plant should be reviewed and chlorine dosages should be reduced to comply with the objectives of the Ministry of the Environment. While the lower reaches of German Mills Creek still have high levels of nitrogen and phosphorus, it would appear that this area is suitable for a variety of stream life. Since the level of BOD in the effluent is very low during dry periods, there appears to be no significant dissolved oxygen problem in the Creek.

Since the present study was carried out under conditions of minimal hydraulic loadings on the plant and hence optimum treatment, it is considered that the survey reflects better-than-average conditions.

Ideally, it would be desirable to reduce the flow from the Pugsley Street Plant into German Mills Creek as much as

possible. However, the reduction in flow of 110,000 IGPD at the Pugsley Sewage Treatment Plant (associated with the transfer of flows from the Arnold Street pumping station) would not result in any substantial alteration in the water quality condition of German Mills Creek.

APPENDIX A

1. 1975 field survey carried out by the Central Region.

2. 1966 O.W.R.C. report entitled "Natural Purification In German Mills Creek (Don River Basin) Downstream From The Town of Richmond Hill".

3. 1966 O.W.R.C. report entitled "Biological Survey of The German Mills Creek".

4. Several years data from the Ministry of the Environment water-quality monitoring station on German Mills Creek, located approximately 1 mile downstream of the Pugsley Street Plant.

5. Several years flow data from the Ministry of the Environment staff gauge on German Mills Creek, located approximately 1 mile downstream of the Pugsley Street Plant.

6. Meteriological data compiled by staff at the Pugsley Street Plant.

APPENDIX B

The following outlines the parameters used for each of the 12 sampling runs.

July 29 - temperature, dissolved oxygen, chlorine, bacteria (TC, FC, FS), *chemistry

Aug. 5 - see July 29

Aug. 11 - see July 29

Aug. 13 - day run - temperature, dissolved oxygen, chlorine, bacteria (TC, FC, FS), chemistry, threshold odour.

Aug. 14 - night run - temperature, dissolved oxygen, bacteria (TC, FC, FS), chemistry, threshold odour.

Aug. 29 - see July 29.

Sept. 2 - 1st run (10.05 - 11.50 am) - temperature, dissolved oxygen, bacteria (TC, FC, FS)

- 2nd run (1.40 - 3.50 pm) - temperature, dissolved oxygen, chlorine

- 3rd run (4.55 - 7.05 pm) - temperature, dissolved oxygen, bacteria (TC, FC, FS)

- 4th run (9.30 - 10.40 pm) - temperature, dissolved oxygen, chemistry.

Sept. 3 - 5th run (12.20 - 2.10 am) - temperature, dissolved oxygen, bacteria (TC, FC, FS)

- 6th run (5.10 - 6.10 am) - temperature, dissolved oxygen.

In addition to the above, streamflow measurements were obtained at stations 2, 4, 7, 8 and 9 on September 4.

*BOD_5, dissolved solids, suspended solids, free ammonia, total kjeldahl nitrogen, nitrite, nitrate, total phosphorus, dissolved reactive phosphorus, total organic carbon, conductivity.

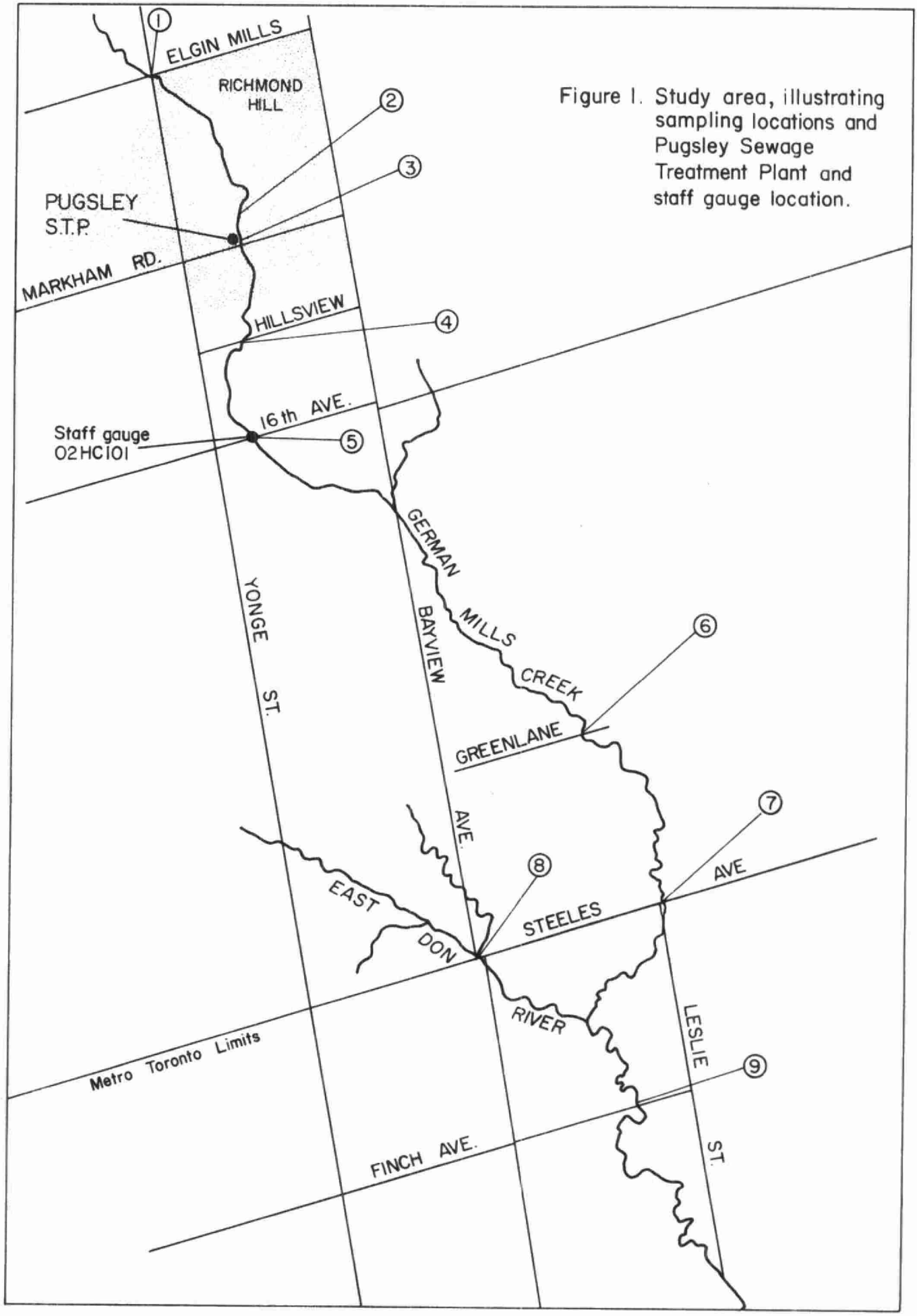


Figure 1. Study area, illustrating sampling locations and Pugsley Sewage Treatment Plant and staff gauge location.

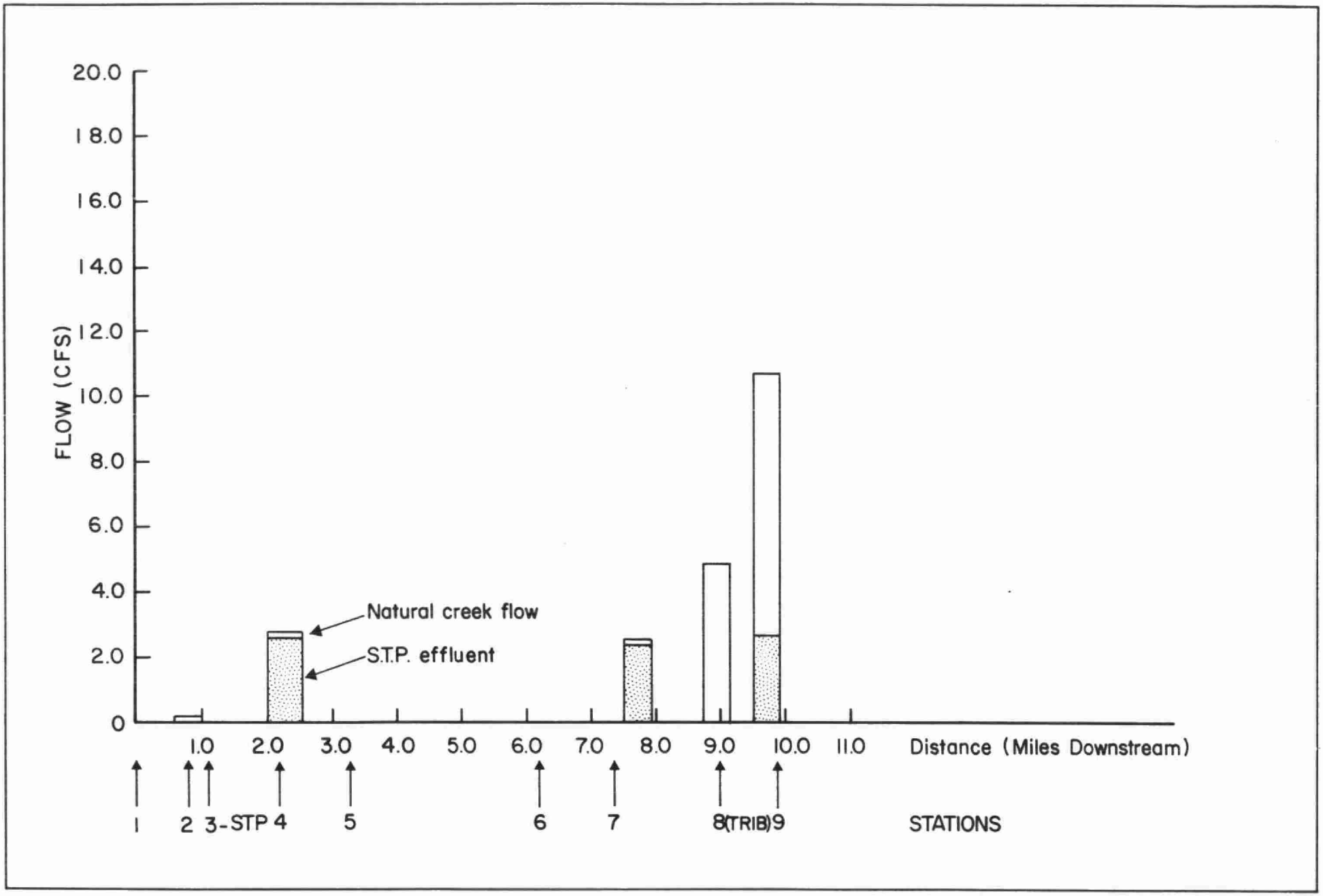


Figure 2. Measured stream flows at five locations, September 4, 1975.

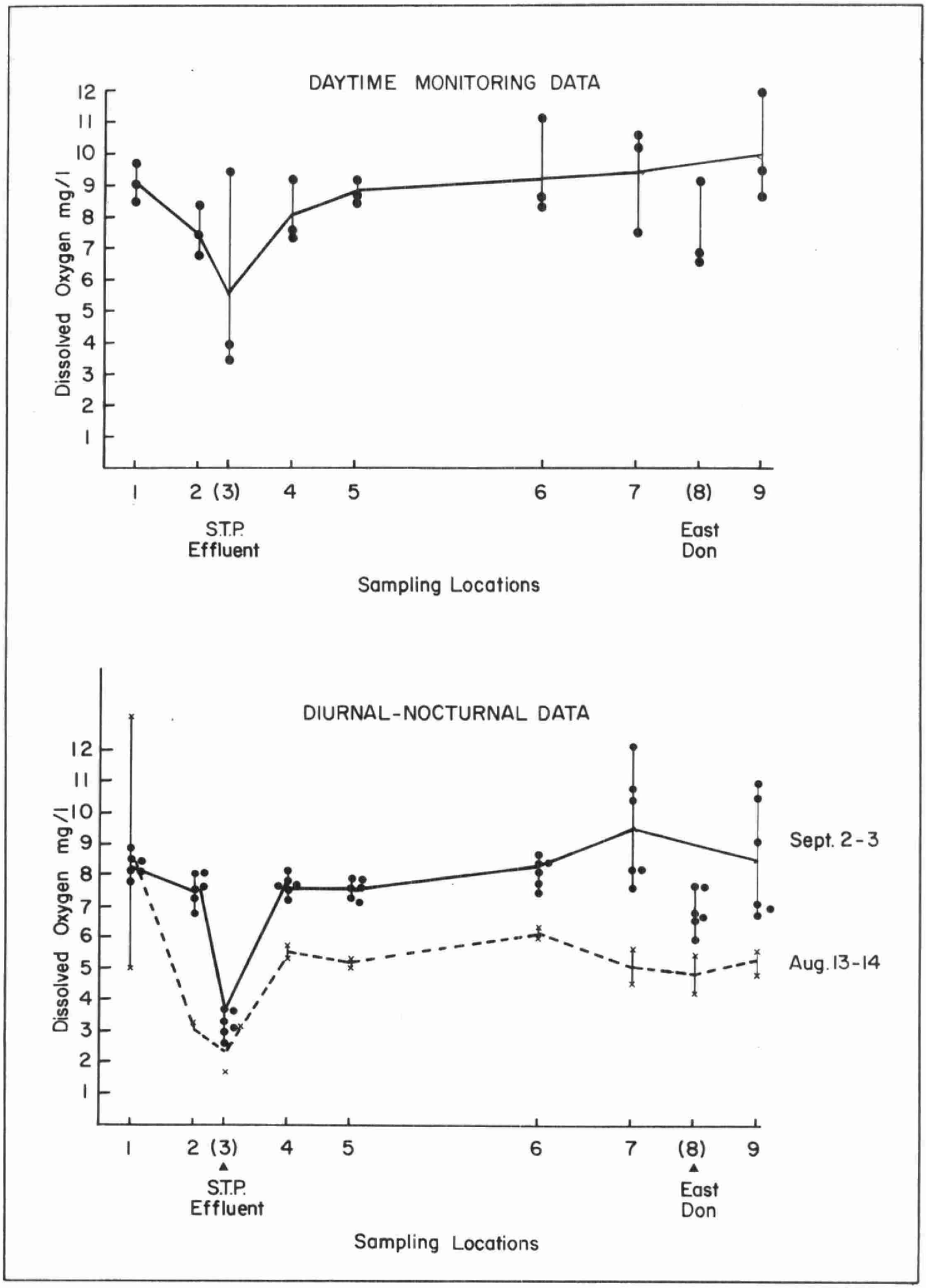


Figure 3. Dissolved Oxygen

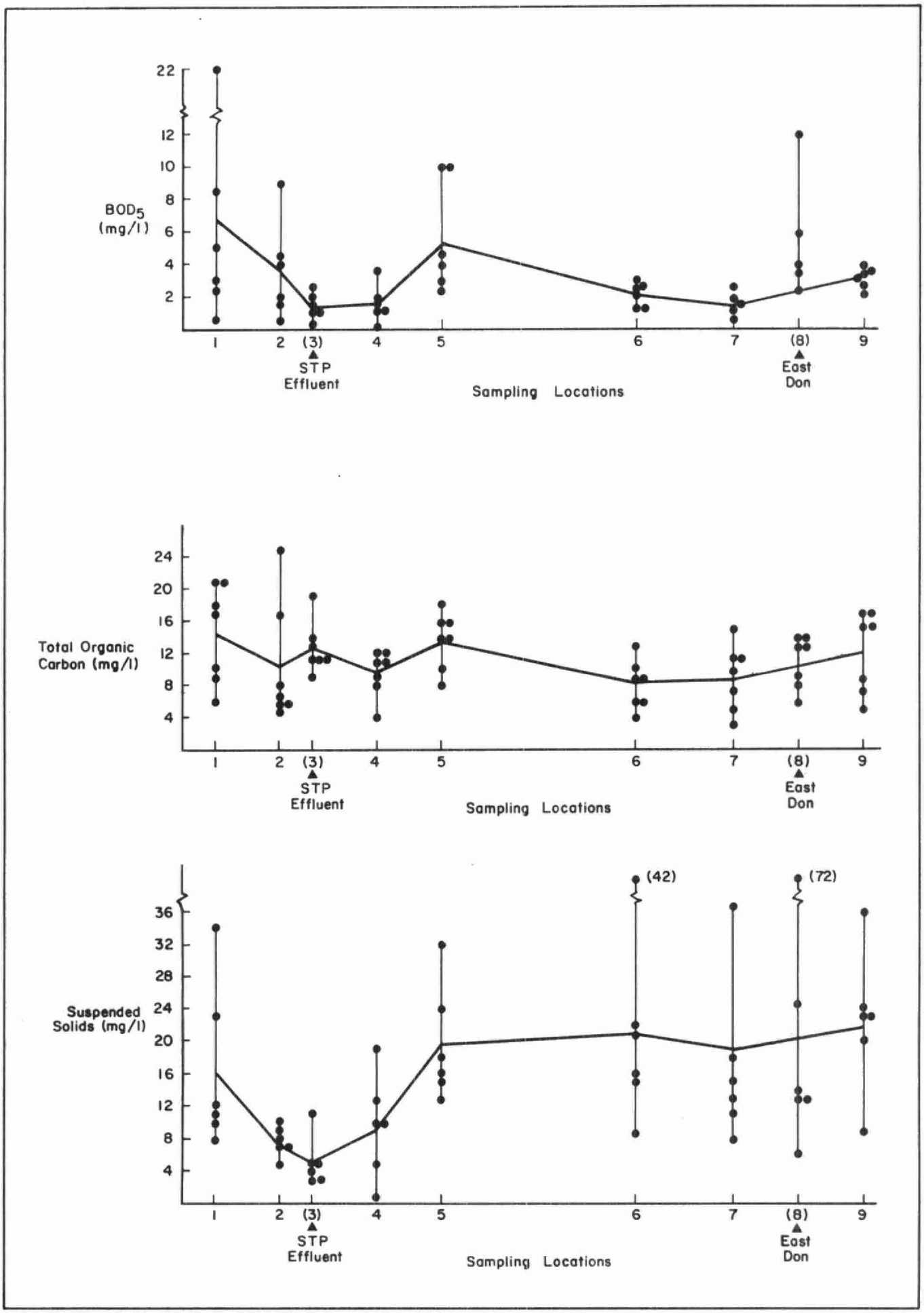


Figure 4. BOD_5 , Total Organic Carbon, Suspended Solids

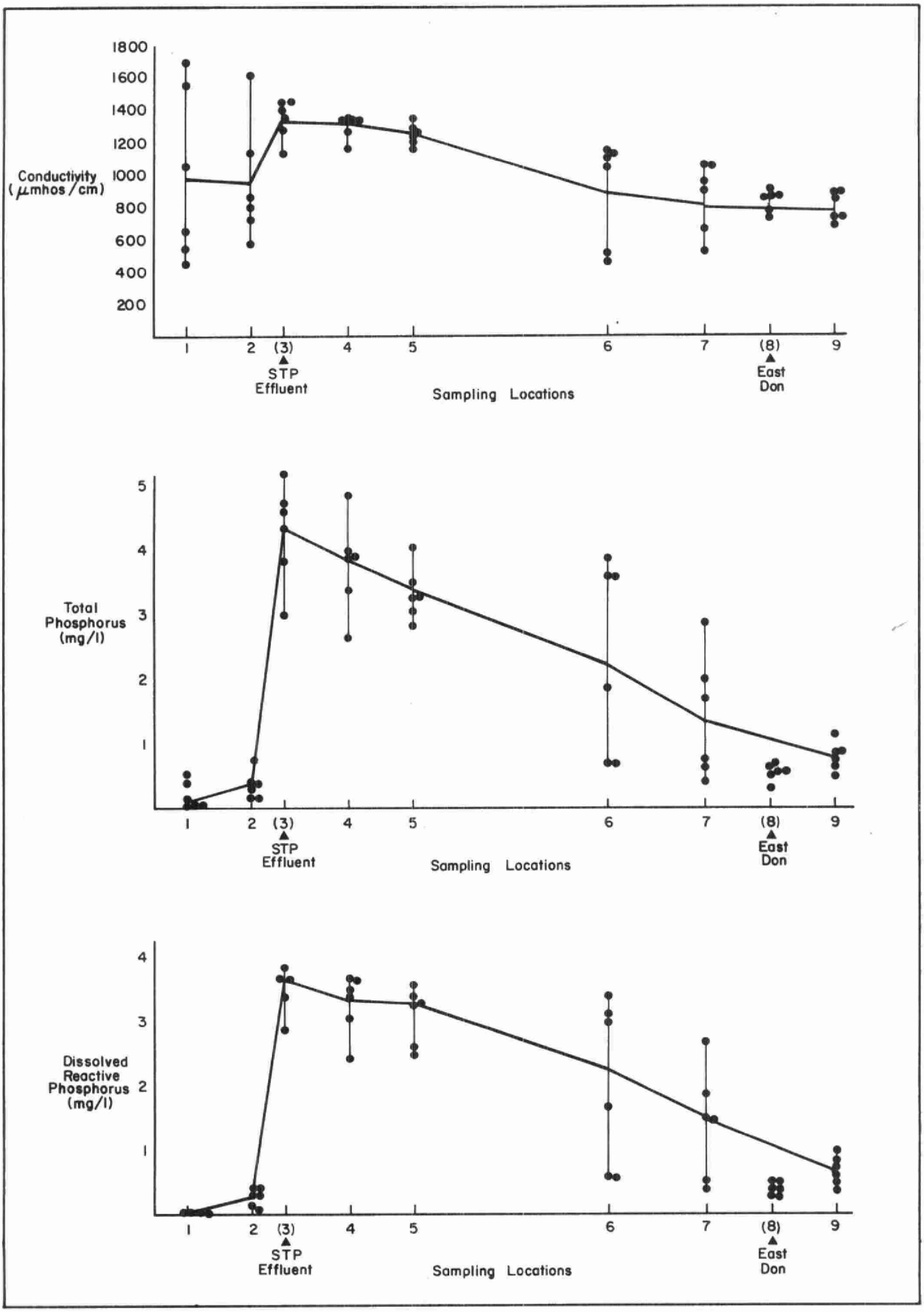
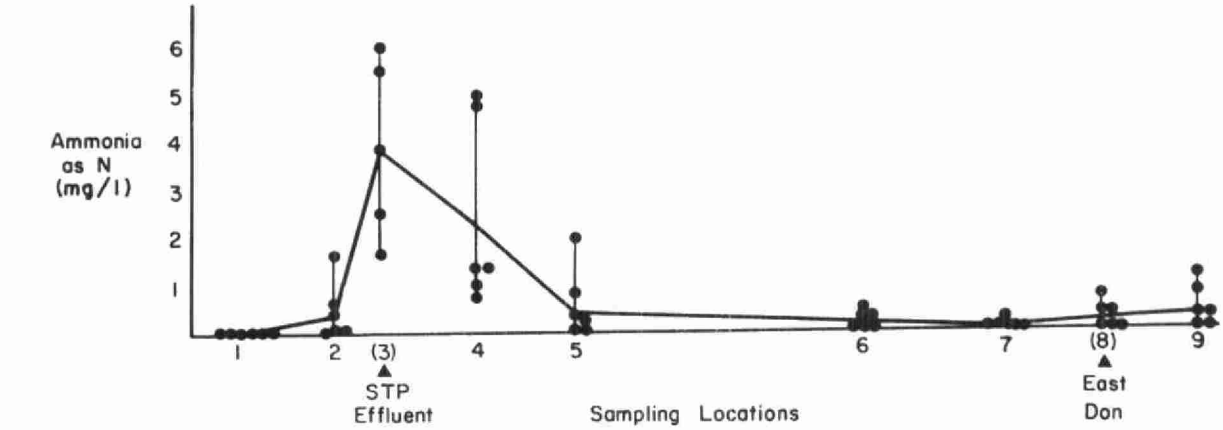
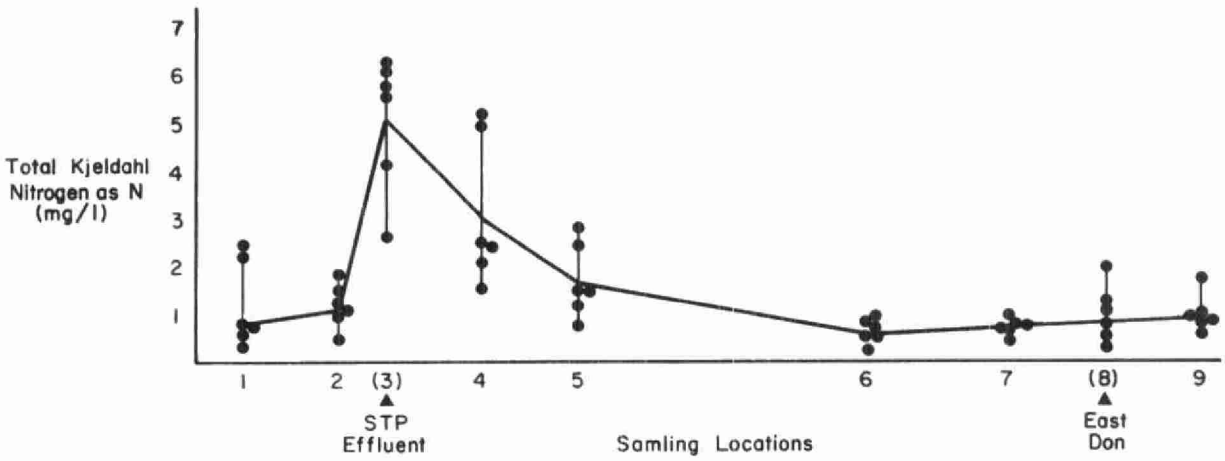


Figure 5. Conductivity, Total Phosphorus and Dissolved Reactive Phosphorus





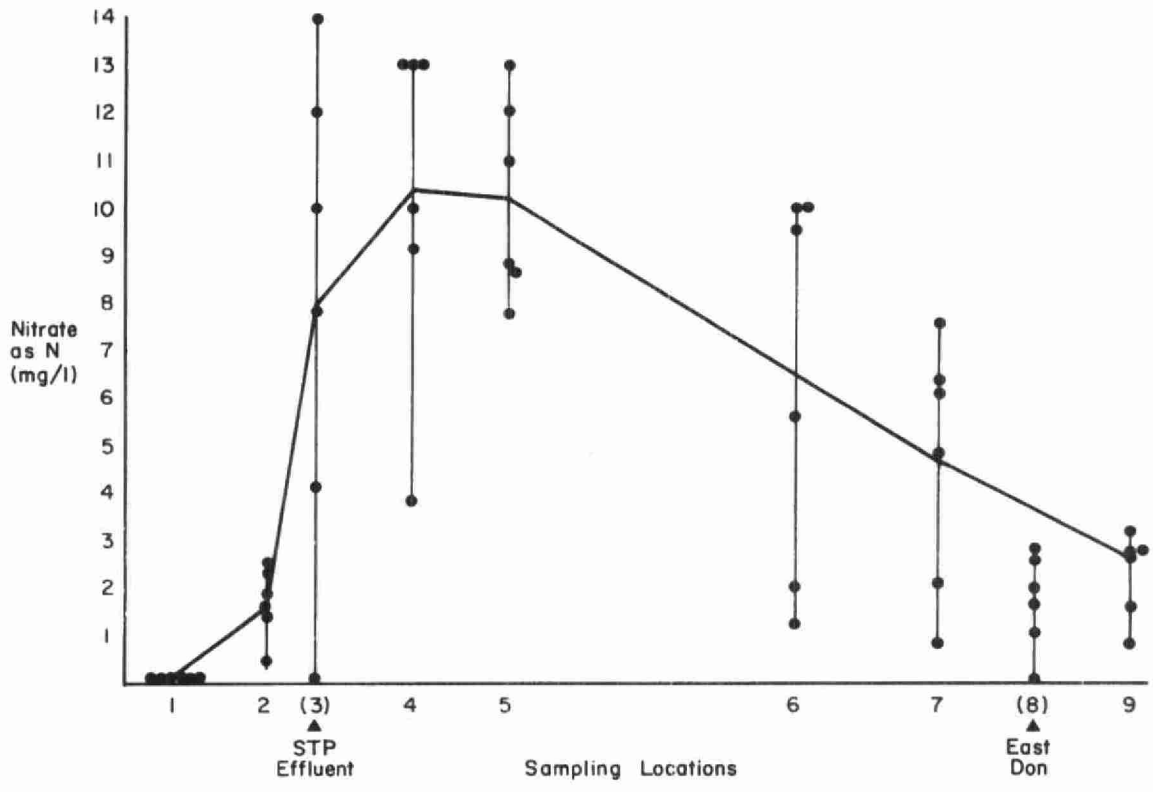


Figure 6. Ammonia, Total Kjeldahl and Nitrate Nitrogen

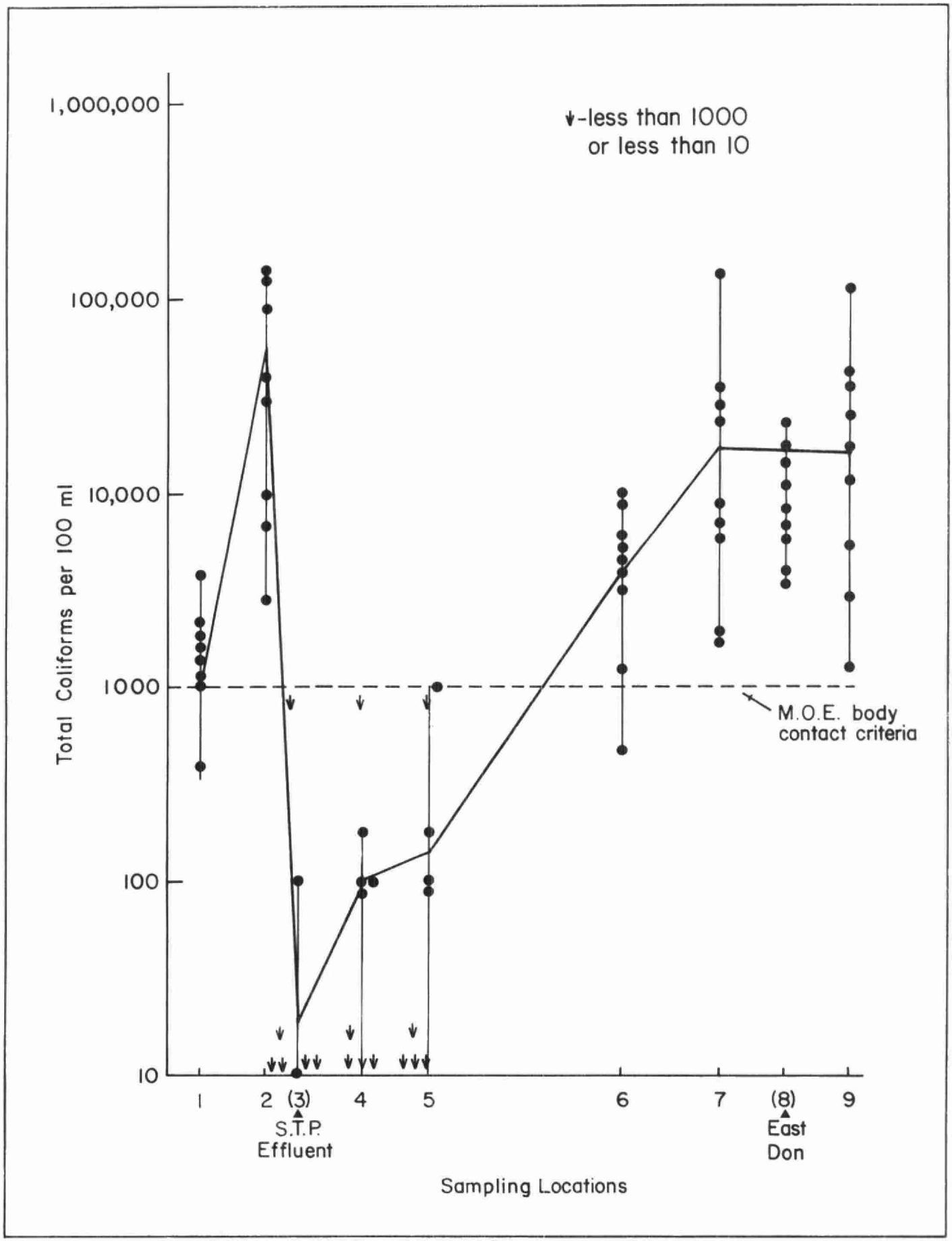


Figure 7. Total Coliforms

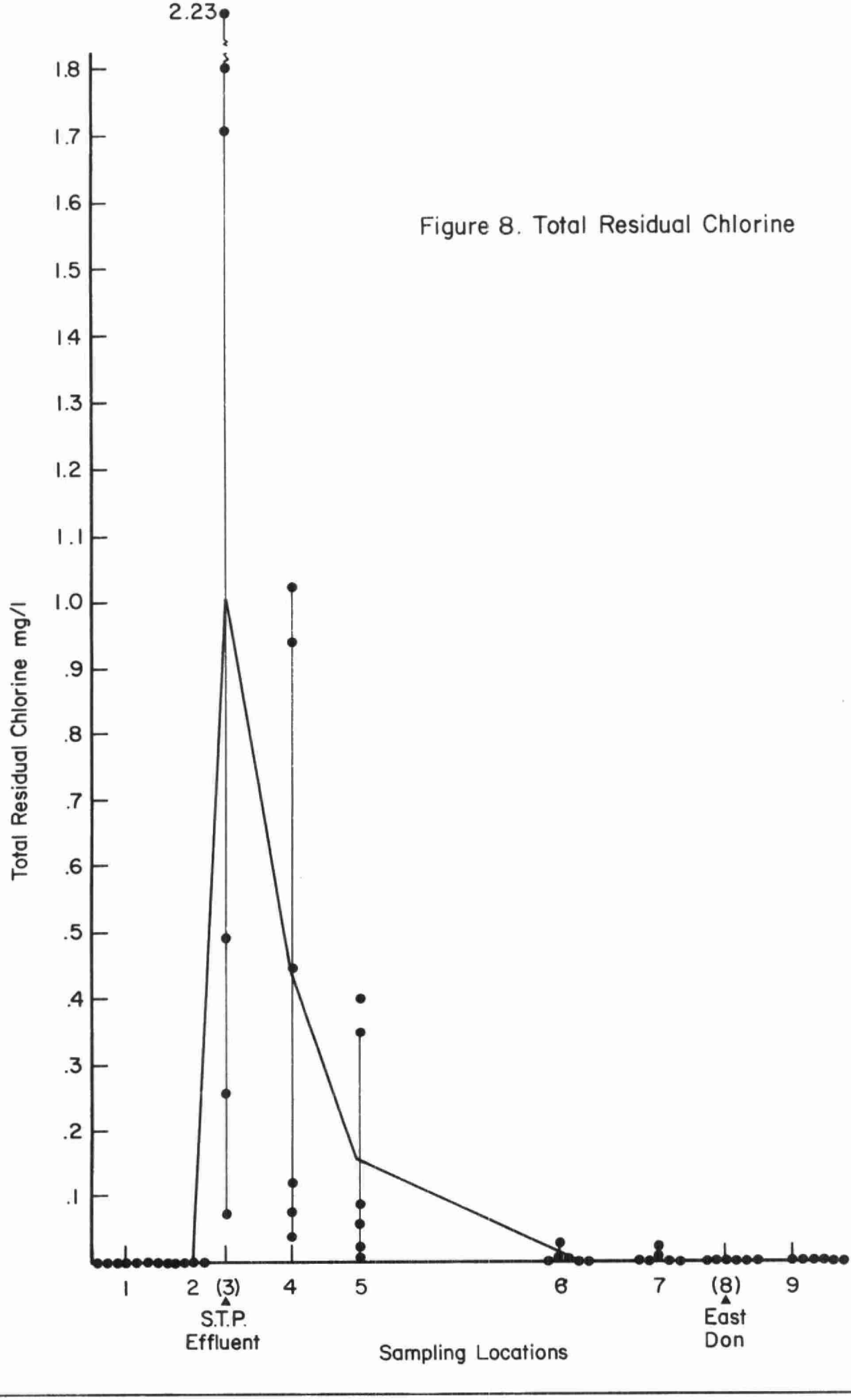


Figure 8. Total Residual Chlorine